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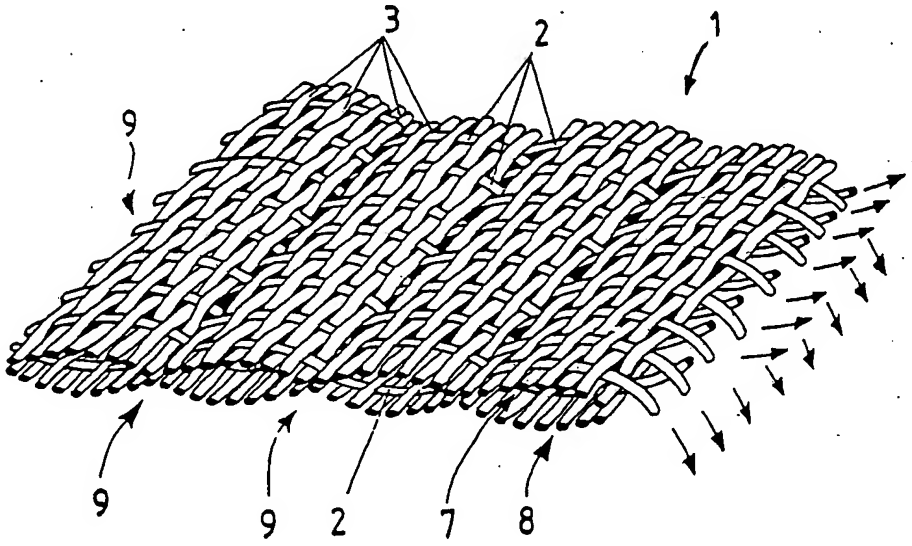
(54) Title: A METHOD FOR MANUFACTURING A LAMINATING REINFORCED FIBRE STRUCTURE AND A CORRESPONDING REINFORCED FIBRE STRUCTURE



(57) Abstract

The object of the invention is a method for manufacturing a laminating reinforced fibre structure (1), in which fibre layers (7, 8) made of cross-woven warp or weft yarn bundles are manufactured as a warp structure, these being tied together with ties (9) and a filler (4) is placed in the channel formed by the layers one top of each other and the ties. In accordance with the invention two fiber layers (7, 8) one top of one another are woven together in a manner that is as such known, in such a way that the warp (2) or alternatively weft (3) bundles of yarns run in turn in the upper and lower structures thus forming large channels in relation to the size of the fabric and pieces impermeable to a binder substance is used as a filler (4).

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A METHOD FOR MANUFACTURING A LAMINATING REINFORCED FIBRE STRUCTURE AND A CORRESPONDING REINFORCED FIBRE STRUCTURE

The object of the invention is a method for manufacturing a laminating reinforced fibre structure, in which fibre layers are manufactured as a warp structure from cross-woven warp or weft yarn bundles, which are bound to each other by the weave and a filling is put into the channel formed by layers and weaves on top of one another. The reinforced fibre structure obtained is intended to be laminated in the form desired. The invention is also concerned with the reinforced fibre structure.

Multi-layer reinforced fibre structures are shown in patent publications EP 299,309, US 4,854,352, and JP 1-321946(8). Vorwerk & Co, BRD have demonstrated TechnoTex products, in which the woven layers are bound at a considerably short distance from each other by special binding fibres, which by themselves lift the layers away from each other without pressure.

In the aforementioned EP publication a multi-layer fibre structure is shown, in which filler fibres are used between and inside the layers. The layers are bound with separate binding fibres. In several cases the strength between the layers is essentially poorer than that in the direction of the layers.

In the JP publication multi-layer fibre structures are shown, which are woven to one another at regular intervals. The binding fibres are disadvantageous in relation to the loading.

The intention of this invention is to create a new method for manufacturing laminating three-dimensional reinforced fibre structures, and a corresponding reinforced fibre structure. The characteristic features of the method in accordance with the invention are shown in the accompanying Patent Claim 1 and the characteristic features of the corresponding reinforced fibre structure are shown in Patent Claim 6. A large three-dimensional structure in relation to the weave is obtained by using large fillers in the channels formed by two warp structures on top of each other, in which most advantageously either the weft or warp yarn bundles run back and forwards in the upper and lower

layers, in which case the weave between the layers becomes very strong. The filler makes it possible to shape the three-dimensional reinforced fibre structure to an arbitrary shape on a mold. Level layers are advantageously used on top of and beneath the reinforced fibre structure in order to improve the surface strength. In principle filler pieces that are not impregnated with binder material in accordance with the invention can also be used in the fibre structures shown in the aforementioned publications by replacing the filler fibre bundles with these filler pieces. In this way the layer thickness of the structure can be considerably increased and the specific weight reduced.

Foam plastic is lighter than the previously used fibre fillers. A light structure can also be achieved by using hollow fillers. Even hollow metal pipes can be considered. The specific weight of wood is about half that of fibre material.

In what follows the invention is illustrated by referring to the accompanying figures, which shown some forms of application of the invention.

Figure 1 shows a two-layered reinforced fibre structure before placing the fillers.
Figure 2 shows a finished laminating reinforced fibre structure.
Figure 3 shows a reinforced fibre structure formed on a mold.
Figure 4 shows a finished formed reinforced fibre piece.
Figure 5 shows one possible way of manufacturing thicker pieces.
Figure 6 shows a beam structure formed with the aid of a reinforced fibre structure in accordance with the invention.

Figure 1 shows a two-layer reinforced fibre structure, through the layers may be more in number. What is essential is that the layers 7 and 8 on top of one another continually change sides in such a way that their warps 2 run in turn in the upper and lower layers. Their cross points, i.e. points of changing side,

are formed by ties 9, between which several fibres remain. Here the warps and wefts are formed of suitable bundles of fibres. Glass fibres are typically used. Aramid, carbon, ceramic, or other reinforcing fibres may also be used.

The filler pieces must not absorb resin completely, so that the finished product will be light. Foam plastic fillers permit good dampness, heat, and sound insulation. If required foam-type fillers can be removed from a laminated piece.

One or several common weft yarns can also be used as binding points.

A reinforced fibre structure in accordance with Figure 1 is taken to the next stage, in which the ties 9 and the inwardly closing channels of the layers 7 and 8 are filled with filler 4, which may be hollow pieces 4', for examples plastic pipes or foam plastic pieces 4". It is advantageous to use closed-cell foam plastic, for example polythene, which does not absorb resin. Other plastics and rubber can also be considered. These pieces do not necessarily need to be round, but can possibly be of some other cross-sectional form.

The reinforced fibre structure can contain, in addition to the structure in accordance with Figure 1, either on one or both sides even layers, which are loosely bound to these layers from between the ties. By means of them it is possible to obtain a great strength in the direction of the surface.

The fibre structure in accordance with Figure 2 with its fillers is treated with resin and is set in the mold 6 in accordance with Figure 3. The fillers 4 flex and permit the reinforced fibre structure 1' to conform to the shape of the mold.

Figure 4 shows a finished reinforced fibre structure. The fillers 4 except one have been removed. In a corresponding way it is possible to form an arbitrarily formed piece. If a thicker piece is desired layer folding in accordance with Figure 5 can be used, or structures in accordance with Figure 2 can be laid

on top of one another at a suitable angle to each other. The fibre structure can be manufactured in varying thickness to minimize forming.

Heat-forming technique can also be exploited in the reinforced fibre structure in accordance with the invention. A binding substance, for example polyester, is added to the bundles of fibres that run in a vertical direction to the ties, when after weaving the channels are filled with a core, which temporarily forms the aforementioned filler. The binding substance can then be melted momentarily with the aid of heat, when a cell structure blank is formed. The intention of the binding substance is to provide the reinforcing fibres with a suitable stiffness for sufficiently long for the laminating blank to be pressed in the mold into the desired form.

The foam plastic filler may be a thermoplasticly treated material, for example polythene, when pieces of the desired shape are manufactured in the mold with the aid of heat treatment to be laminated.

In the laminating stage the prepreg technique, which is as such known, can be used.

Between the ties there may be a varying amount, typically 10 - 25, of bundles of yarn running in the direction of the ties. In the test piece the polythene pieces have been of a diameter of 10 - 20 mm. In these normal glass fibre fabric (TEX 2400) was used, which was, however, woven together with the second layer in a manner in accordance with the invention. Using at least a 5 mm diameter a unique structure is provided.

Wood or metal can be used as materials for the fillers, especially to create adhesion in a laminating piece. A particularly interesting possibility is to use an expanding compact material as a filler. In this case for example the fillers expand due to the heat of the mold and raise the structure to become stiff.

Patent Claims

1. A method for manufacturing a laminating reinforced fibre structure (1), in which layers (7, 8) of cross-woven warp or weft yarn bundles are manufactured as a warp structure, these being bound to one another by ties (9) and a filler (4) is placed in the channel formed by the layers (7, 8) and the ties, characterized in that two fibre layers (7, 8) are woven together on top of one another in a manner that is as such known in such a way that the warp (2) or alternatively the weft bundles of yarn (3) run one after the other in the upper and lower structure forming in relation to the size of the fabric large channels, and pieces that are impermeable to binder substances are used as filler (4).

2. A method in accordance with Patent Claim 1, characterized in that foam plastic (4") is used as a filler (4), advantageously closed cell foam plastic.

3. A method in accordance with Patent Claim 1, characterized in that hollow pieces (4') are used as a filler (4).

4. A method in accordance with Patent Claim 1, characterized in that wood is used as the material of the filler (4).

5. A method in accordance with Patent Claim 1, characterized in that metal is used as the material of the filler (4).

6. A method in accordance with Patent Claim 1, characterized in that a binder substance is used transverse to the ties (9), which binder substance is stiffened against a core in order to form a blank, after which the core is removed.

7. A method in accordance with Patent Claim 1, characterized in that some compact material is used as a filler,

which expands due to the effect of some external treatment, for example heat.

8. A reinforced fibre structure (1), in which there is a two or more layered structure, which layers (7, 8) are bound to each other by ties (9) that together with them form channels, in which fillers (4) are placed, and which fibre structure is intended to be laminated in the desired form, characterized in that the fillers (4) are of a material impermeable to the binder substance.

9. A reinforced fibre structure (1) in accordance with Patent Claim 8, characterized in that foam plastic (4") is used as the filler.

10. A reinforced fibre structure (1) in accordance with Patent Claim 8, characterized in that one of the following, plastic, rubber, wood, metal is used as the filler.

11. A reinforced fibre structure (1) in accordance with Patent Claims 8, 9, or 10, characterized in that the two fibre layers (7, 8) in the fibre structure that lie on top of each other are woven together in such a way the warp (2) or alternatively the weft yarn bundles (3) run in turn in the upper or lower structure thus forming large channels in relation to the size of the fabric.

12. A reinforced fibre structure (1) in accordance with one of Patent Claims 8 - 11, characterized in that at least one side of the reinforced fibre structure has a continuous fibre layer (5).

13. A reinforced fibre structure (1) in accordance with one of Patent Claims 8 - 11, characterized in that the diameter of the filler is at least 5 mm.

14. A reinforced fibre structure (1) in accordance with one of Patent Claims 8 - 11, characterized in that a hollow piece (4') is the filler.

15. A reinforced fibre structure (1) in accordance with Patent Claim 11, characterized in that the layers interlocking with each other have one or more common warp/weft yarn at the tie points.

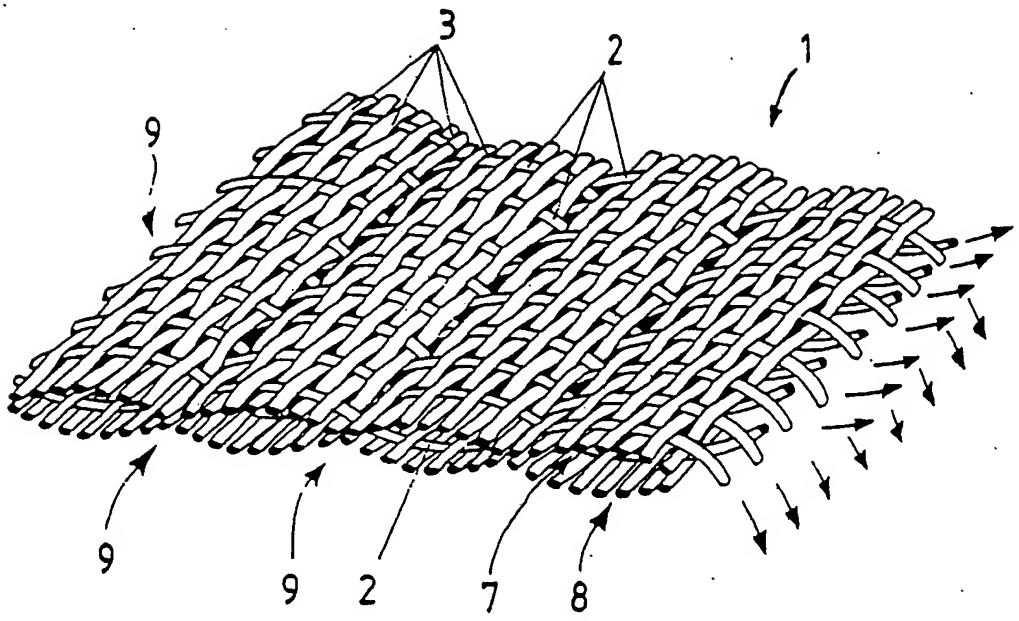

Fig. 1

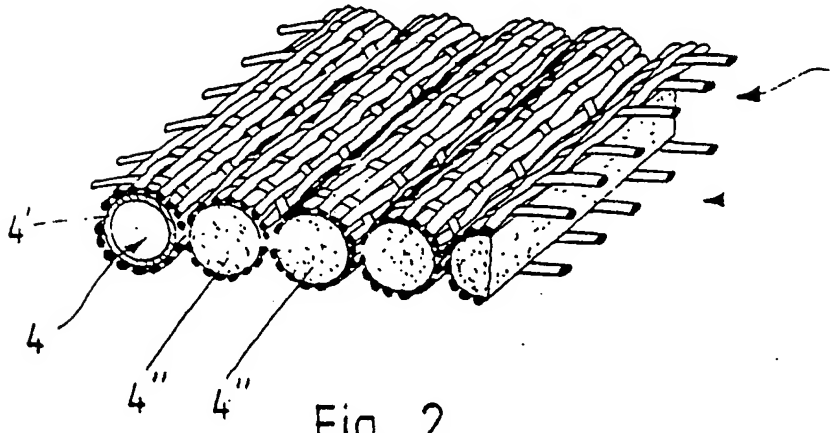

Fig. 2

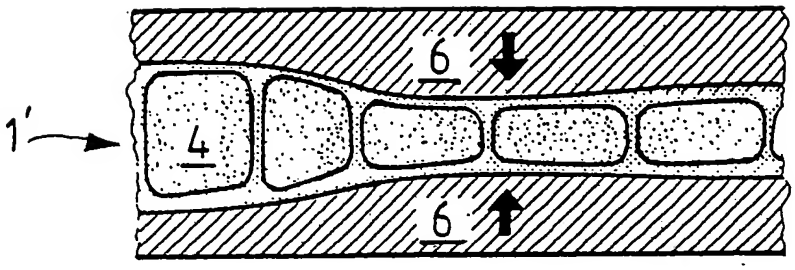

Fig. 3

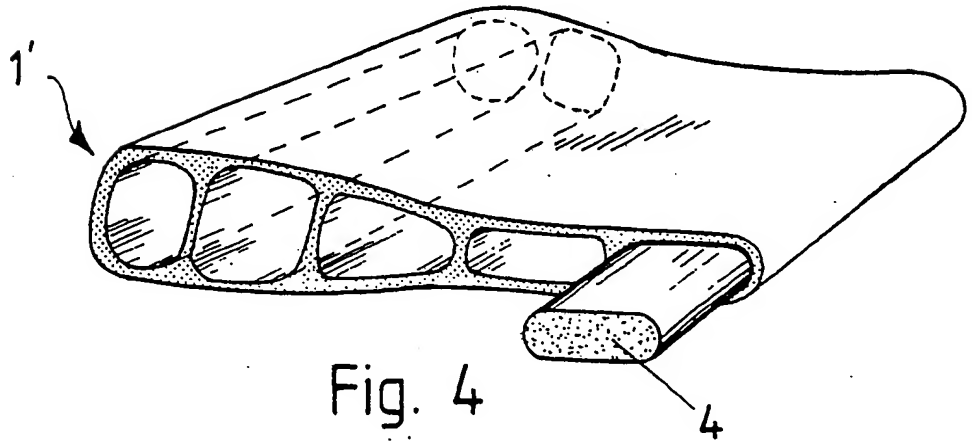

Fig. 4

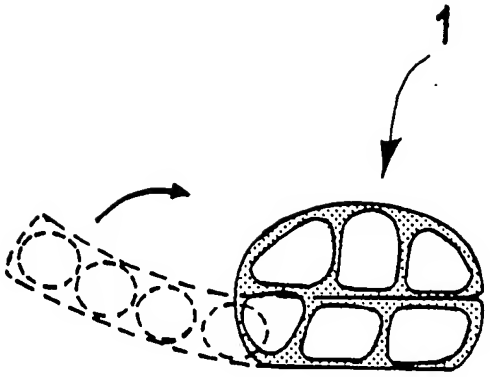

Fig. 5

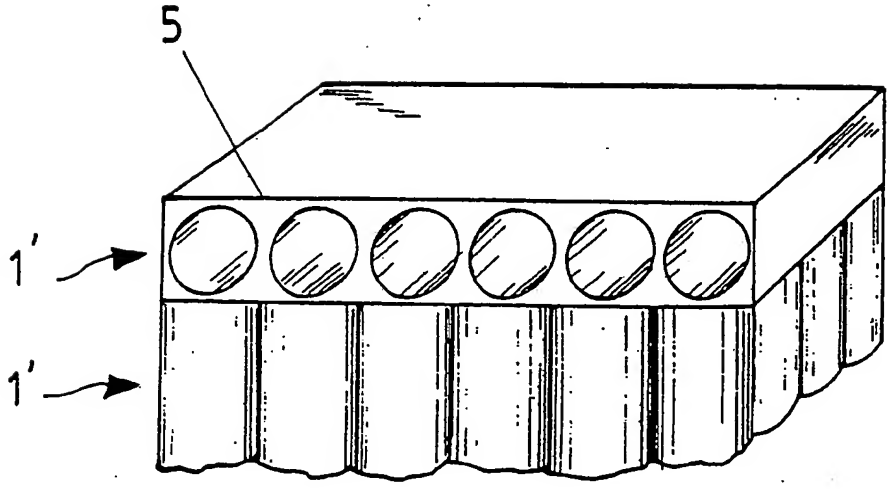

Fig. 6

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 92/00241

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: D 03 D 11/02

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	D 03 D; B 32 B; B 29 B; B 29 D; B 29 C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	GB, A, 1277260 (AROVA NIEDERLENZ AKTIENGESELLSCHAFT ET AL) 7 June 1972, see figures 1,4; claim 1 --	1-15
A	EP, A2, 0190039 (ASAHI KASEI KOGYO KABUSHIKI KAISHA) 6 August 1986, see page 26, line 8 - line 13; page 10; claim 1 --	1-15
A	EP, A2, 0299309 (VORWERK & CO. INTERHOLDING GMBH) 18 January 1989, see figure 2; claim 1 --	1-15

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
16th December 1992	22-12-1992
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Nils Ekström

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/FI 92/00241

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
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